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01e. Characterization and evaluation of rice genetic diversity, including 'omics'

FIELD SCALE HIGH THROUGHPUT PHENOTYPING FOR GENE DISCOVERY AND AGRONOMIC IMPROVEMENT

S. Klassen[1], H. Leung[2], M. Baraoidan[1], K. McNally[3], M. Dingkuhn[1], A. Henry[1], J. Leach[4], J. McKay[4], J. Mojica[4], P. Tanger[4], D. Bush[4]
[1]CESD, International Rice Research Institute, Los Baños, Philippines
[2]PBGB, International Rice Research Institute, Los Baños, Philippines
[3]TTCGRC, International Rice Research Institute, Los Baños, Philippines
[4]BSPM, Colorado State University, Fort Collins, USA

Purpose:
Improving crop yields through breeding requires genetic variation and precise prediction of a genotype's fit to a target environment. Next generation breeding approaches place an ever increasing demand for large field scale approaches to phenomics. With current advances in characterizing DNA polymorphism, phenotyping may be the rate limiting step. Here we present results from the evaluation of three diverse rice populations using high throughput phenotyping (HTP) at the International Rice Research Institute, Philippines.

Approach and methods used:
The HTP platform incorporated eight sets of sensors for monitoring multispectral reflectance, canopy temperature, and plant height on a tractor-mounted boom equipped with GPS guidance. The plot level sensors provided non-destructive measurements at an overall throughput of 2500 plots per hour. Three populations have now been evaluated using HTP including: a large set of recombinant inbred lines (1,700 IR64 x Aswina RILs) for biomass traits; a diversity panel of 300 Indica accessions as part of a global phenotyping project (PRAY); and, a drought screening panel (300 IR64 x Dular RILs) evaluated under well watered and drought stress conditions.

Key results:
There was a high level of genetic correlation between midseason HTP and manually collected traits at harvest. Reflectance in the near infrared and red edge regions were strongly correlated with time to flowering, and end of season biomass, plant height and harvest index. Vegetation indices derived from reflectance values showed even stronger correlations overall, especially with yield and harvest index. Estimates of broad sense heritability were highest for manually collected traits but also high for HTP.

Synthesis and Applications:
HTP technologies can empower gene discovery and agronomic improvement by enabling the linkage of genetic diversity with physiological, morphological, and agronomic variation. The ease and non-destructive nature of HTP provides the unique ability to monitor dynamic plant responses such as plant growth and development and responses to stress. These results suggest HTP will be useful for association mapping of QTL for important agronomic traits such as biomass, stress resistance, and yield. Future possibilities include the use of HTP technologies for more efficient and systematic screening of large breeding populations and multi-environment testing of advanced breeding materials.